Fisheries and Oceans Canada | Pêches et Océans Canada
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Quebec Region
Canadian Science Advisory Secretariat
Science Advisory Report 2011/007

ASSESSMENT OF THE QUEBEC NORTH SHORE (DIVISION 4S) HERRING STOCKS IN 2010

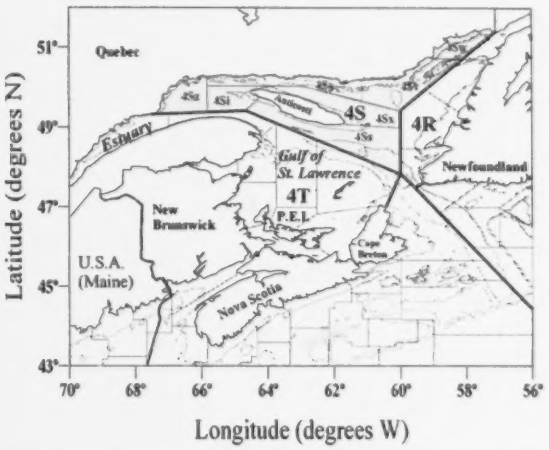

Figure 1. Map of unit areas of NAFO Division 4S (Quebec North Shore). Division 4S is identified by the coloured area.

Context

Herring is a pelagic fish that has been fished for many years. The world's largest catches are made in Norway, Iceland and Canada. On the Canadian east coast, the main fishery areas are located southwest of Nova Scotia, in the Bay of Fundy, in the southern Gulf of St. Lawrence and along the eastern, southeastern and western coasts of Newfoundland. Herring are also caught on the North Shore of Quebec. This area is associated with NAFO Division 4S and Management Area 15. Division 4S extends from unit area 4Sz, to the west, to unit areas 4Sv and 4Sw to the east (Figure 1). The main fishing gear is gillnet (246 permits), in spring in area 4Sz, and later in late summer and early fall in unit areas 4Sv and 4Sw. In recent years, traps (24 permits) and the purse seine (9 permits) have been used in these two areas. Between 1984 and 2009, the reported herring catches totalled on average 478 t per year. Actual catches are likely higher because the bait fishery (265 permits) is not closely monitored and associated catches are not estimated.

For now, there is no SPA (Sequential Population Analysis) type of analytical assessment conducted on the two Quebec North Shore herring spawning stocks. Consequently, it is not possible to calculate their respective abundance, fishing mortality, and limit reference points which could help to establish, according to the Precautionary approach, a strategic framework for the fishery and a Total Allowable Catch (TAC). Since 1992, the Quebec North Shore herring stocks are managed using a preventive TAC of 4,000 t. The last Integrated Fisheries Management Plan ended December 31, 2010.

The last assessment of the two herring spawning stocks from Division 4S goes back to 2006. The Fisheries and Aquaculture Management Branch has requested scientific advice on these stocks for the 2011 and 2012 fishing seasons. This document should meet, at least in part, their request because it updates the assessment of the status of this resource based on the information currently available.

May 2011

Canada

SUMMARY

- Since 2006, herring catches on the North Shore of Quebec have ranged between 120 and 1,078 t. They totalled 403 t in 2010 compared to an annual average (2000-2009) of 308 t. Most herring catches were made in unit area 4Sw.

- Traditionally, the most important herring catches on the North Shore of Quebec were from a gillnet fishery. However, since 2008, the great majority of catches has been made with trap.

- The demographic structure of the two herring spawning stocks of the Quebec North Shore is characterized by the occasional occurrence of dominant year-classes. Some of these year-classes, such as 1980, 1982, 1994, and 2002 for spring spawners, and 1979, 1995 and 2000 for fall spawners, were observed over several years which suggests a low exploitation rate.

- There has been a clear downward trend in the mean length and weight at age for both herring spawning stocks since 1983. Maturity at length has varied little over the years. The length at 50% maturity (L_{50}) is close to 250 mm.

- Based on the 2010 acoustic survey conducted in unit area 4Sw, the total biomass index of spring spawners totalled 3,500 t compared to 80,855 t for fall spawners.

- Quebec North Shore herring stocks are managed using a preventive Total Allowable Catch (TAC) of 4,000 t. Catches could be higher than those currently carried out

- The information currently available is not sufficient to determine exactly how much higher catches could be. Any increase in fishing effort should be made gradually and be accompanied by strict monitoring of catches. Herring catches are well under the TAC.

INTRODUCTION

Species Biology

Herring (*Clupea harengus harengus*) is a pelagic fish that frequents cold North Atlantic waters. Its distribution in Canada extends from the coasts of Nova Scotia to the coasts of Labrador. It travels in tight schools in order to feed mainly on small zooplankton (< 5 mm, mostly copepods), to spawn near the coast and to overwinter in deeper waters. The same herring return to the same spawning, feeding and wintering sites year after year. This "homing" phenomenon is attributed to a learning behaviour or social transmission from adults to younger cohorts upon their arrival in a population. At spawning, eggs attach themselves to the sea floor, forming a carpet of a few centimetres thick. The egg incubation time and larval growth are linked to ambient characteristics of the environment with the most significant being water temperature. Most herring reach sexual maturity at five years of age and at a length of about 300 mm. Compared with other herring populations, northern Gulf of St. Lawrence herring are characterized by two spawning stocks. Spring herring generally spawn in April and May, and fall herring in August and September.

ANALYSIS

Commercial Fishery

General pattern of the fishery

Herring catches on the Quebec North Shore (NAFO Division 4S; Figure 1) saw rapid expansion through the 1970s. From less than 80 t per year for the 1960-1970 period, catches have reached an average of 595 t since 1979 (Figure 2).

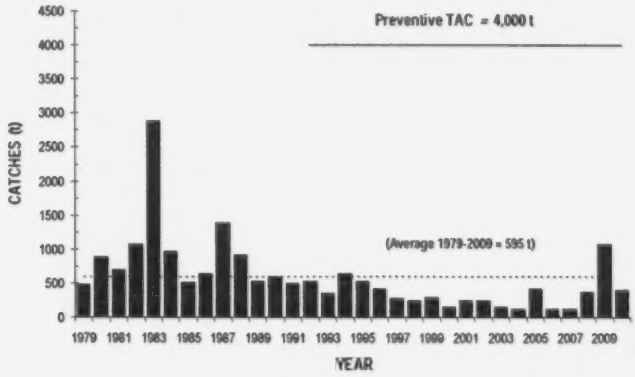

Figure 2. Herring catches and TAC (t) in NAFO Division 4S between 1979 and 2010 (the average catches for the years 1979-2009 are indicated by the horizontal dotted line).

Table 1. Annual herring catches (t) in the main unit areas on the Quebec North Shore, NAFO Division 4S, between 1984 and 2010.

REGION -	AVERAGE		YEAR											AVERAGE
UNIT AREA	1984-1989	1990-1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*	2000-2009
4S EAST														
4Sv	358	45	4	10	38	27	15	12	8	17	4	24	10	16
4Sw	137	76	63	124	82	16	24	351	50	26	371	1051	388	216
4Sx	0	16	0	0	0	0	0	0	0	0	0	0	0	0
4Ss	0	0	0	0	1	0	1	0	0	0	0	0	0	0
Total			*67*	*134*	*119*	*43*	*40*	*363*	*58*	*42*	*375*	*1075*	*398*	232
4S WEST														
Si	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sy	14	27	0	1	0	0	0	0	0	0	0	0	0	0
Sz	318	274	94	116	132	114	87	59	70	51	4	3	5	73
Other	0	0	0	0	0	0	0	0	0	27	0	0	0	3
Total			*94*	*117*	*132*	*114*	*87*	*59*	*70*	*78*	*5*	*3*	*5*	76
GRAND TOTAL			161	250	251	157	127	423	129	120	380	1078	403	308

* Preliminary

Despite huge fishing areas, most herring catches on the Quebec North Shore are concentrated in only three unit areas, namely 4Sz in Division 4S WEST and 4Sv 4Sw in Division 4S EAST (Figure 1). Average annual herring catches in 4Sz totalled 318 t and 274 t for the 1984-1989

and 1990-1999 periods, and finally 73 t for the 2000-2009 period (Table 1). For the same periods, average annual catches totalled 358 t, 45 t and 16 t in 4Sv compared to 137 t, 76 t and 216 t in 4Sw.

From 1984 to 1993, the proportion of catches occurring in Division 4S WEST gradually increased compared to Division 4S EAST (Figure 3). Since then, the proportion of catches occurring in Division 4S EAST has increased and represented over 95% since 2008.

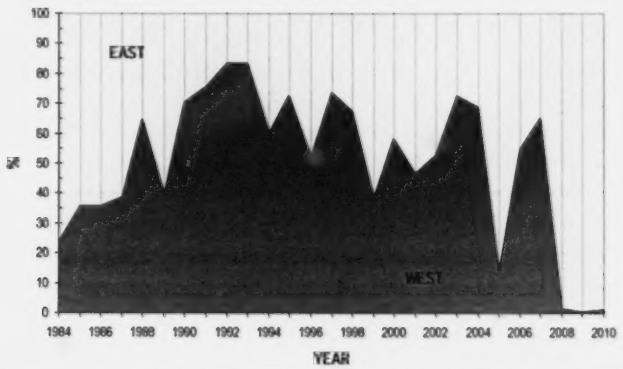

Figure 3. Percentages of herring catches between EAST and WEST portions of NAFO Division 4S, from 1984 to 2010.

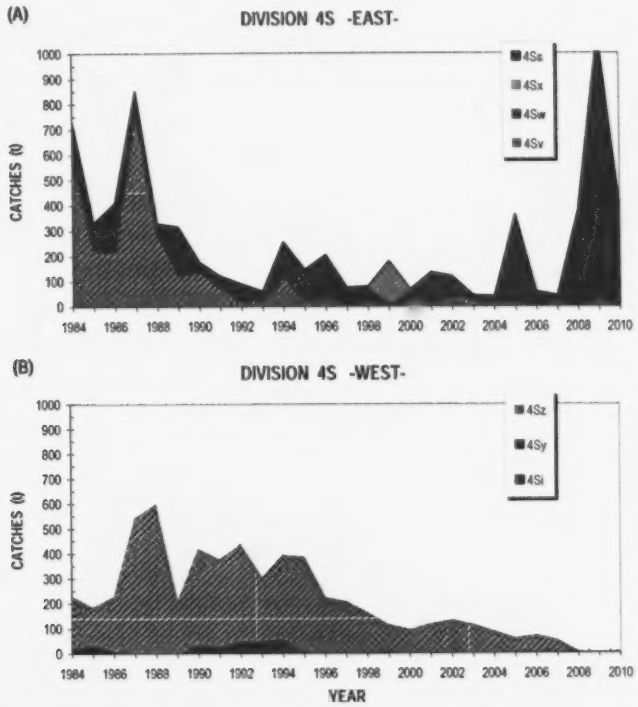

Figure 4. Cumulative commercial herring catches (t) for unit areas of NAFO Division 4S, EAST (A) and WEST (B) portions, from 1984 to 2010.

During the 1980s, the most significant herring catches in Division 4S EAST were made in unit area 4Sv and since the mid-1990s, in area 4Sw (Figure 4A). In Division 4S WEST, most catches have taken place in unit area 4Sz (Figure 4B).

Temporal pattern of the fishery

The herring fishery on the Quebec North Shore begins in the spring in unit area 4Sz, and continues in late summer and early fall in areas 4Sv and 4Sw. Over the years, median fishing dates in area 4Sz have varied little and generally occur around May 30th (day 150 of the year) (Figure 5A). However, fishing seasons have finished earlier since the late 1990s. In areas 4Sv and 4Sw, median fishing dates were more variable and occurred between June 24th (day 175) and August 13th (day 225) (Figure 5B). Fishing seasons in these two unit areas have also finished earlier since the late 1990s.

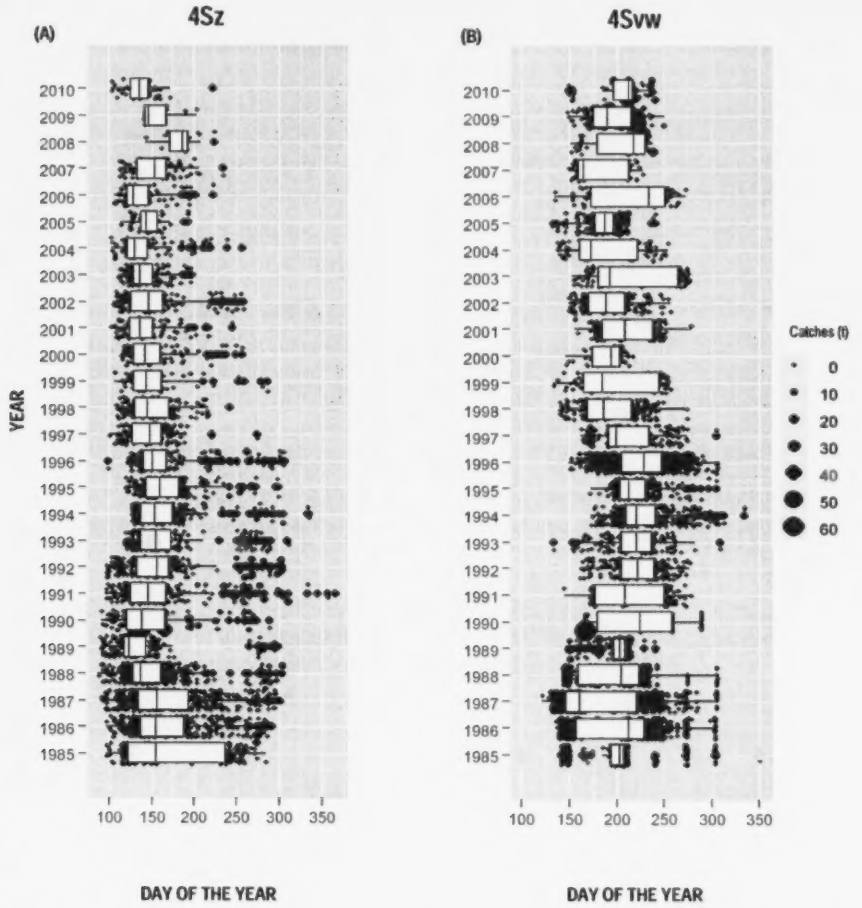

Figure 5. Temporal pattern of the herring fishery in unit areas 4Sz (A) and 4Svw (B) in NAFO Division 4S (Quebec North Shore). The rectangular boxes represent the dates when 25, 50 (median) and 75% of the catches are realized.

Fishing gear

The main fishing gear used for catching herring on the Quebec North Shore is the gillnet. From 1984 to 1989, average annual catches with this gear were 491 t in Division 4S EAST and 294 t in 4S WEST (Table 2). These averages dropped to 111 t and 256 t for the 1990-1999 period and to 64 t and 75 t for the 2000-2009 period. For Division 4S as a whole, gillnet catches have shown a clear downward trend since 1987 (Figure 6). In 2005 and since 2008, the most significant herring catches have been made with traps. In Division 4S EAST, trap fishery catches totalled 307 t in 2008 compared to 853 t in 2009 and 254 t in 2010. The third most common fishing gear is the purse senne with catches of 102 t and 59 t in 2009 and 2010 respectively (Table 2).

Table 2. Annual herring catches (t) for the main fishing gears used on the Quebec North Shore, NAFO Division 4S, EAST and WEST portions, from 1984 to 2010.

REGION -	AVERAGE		YEAR											AVERAGE
GEAR	1984-1989	1990-1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010*	2000-2009
4S EAST														
Gillnet	491	111	24	133	86	43	39	101	31	18	44	120	85	64
Purse seine	2	24	0	0	0	0	0	7	22	0	4	102	59	14
Trap	0	1	43	0	32	0	0	254	5	24	307	853	254	152
Other	2	2	1	0	1	0	1	0	0	0	20	0	0	2
Total			*68*	*134*	*119*	*43*	*40*	*363*	*58*	*42*	*375*	*1075*	*398*	232
4S WEST														
Gillnet	294	256	87	116	133	114	87	59	70	78	5	3	5	75
Purse seine	22	40	6	0	0	0	0	0	0	0	0	0	0	1
Trap	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	16	5	0	0	0	0	0	0	0	0	0	0	0	0
Total			*94*	*116*	*133*	*114*	*87*	*59*	*70*	*78*	*5*	*3*	*5*	76
GRAND TOTAL			162	250	251	157	127	423	129	120	380	1078	403	308

* Preliminary

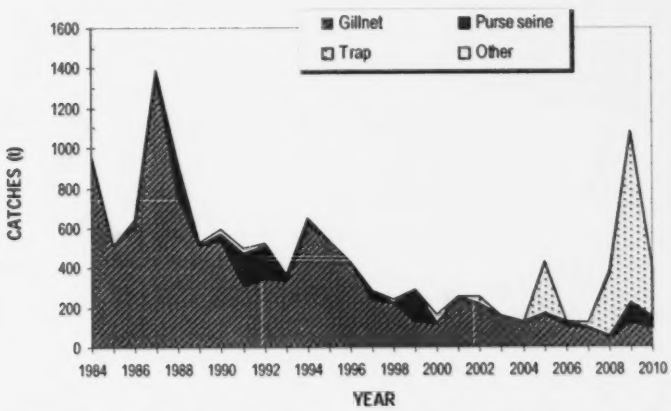

Figure 6. Annual herring catches (t) per fishing gear in NAFO Division 4S, from 1984 to 2010.

Description of Catches

Length and age frequencies

Annual length frequencies of herring sampled on the Quebec North Shore indicate that the maximum lengths reached since the late 1990s have been below those of the 1980s (Figures 7A and 7B). These length frequencies are also characterized by the occurrence of modes associated with dominant year-classes. For spring spawners of unit area 4Sz, these year-classes were those from 1980, 1982, 1990, 1994, and 2002 (Figures 7A and 8A) compared with those from 1979, 1995, and 2000 for fall spawners sampled in unit areas 4Sv and 4Sw (Figures

7B and 8B). The occurrence of these year-classes over several consecutive years suggests a low exploitation rate.

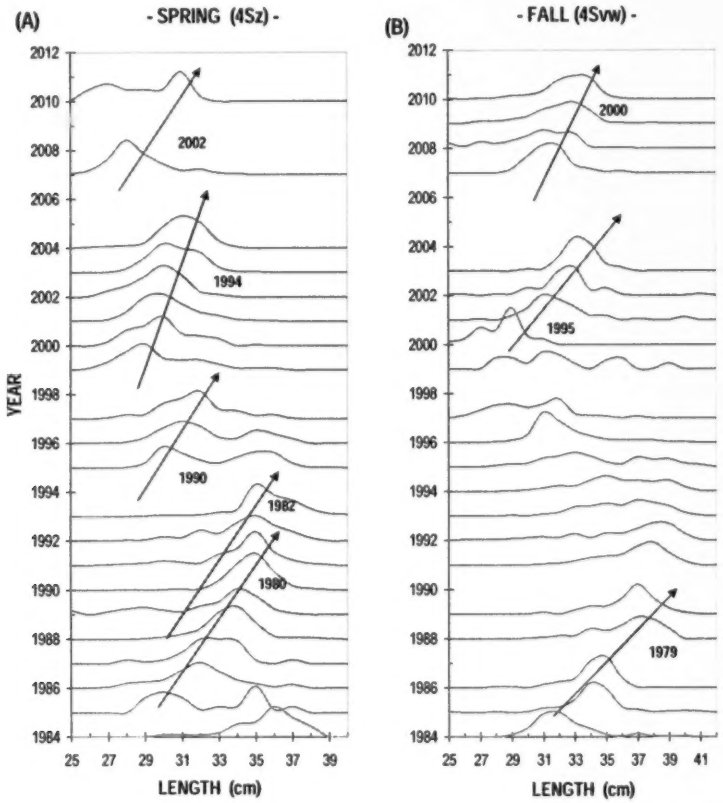

Figure 7. Annual length (cm) frequencies (%) of spring (4Sz) (A) and fall (4Sv, 4Sw) (B) herring from commercial fishery samples on the North Shore of Quebec (NAFO Division 4S), between 1984 and 2010. The dominant year-classes are indicated.

Mean length and weight at age

Mean length and weight at age for both Quebec North Shore herring spawning groups have progressively decreased over the years. Since 1997, mean length and weight (somatic) at age five have remained below 300 mm and 200 g (Figure 9). This trend was also observed with the other age groups. However, condition has not changed.

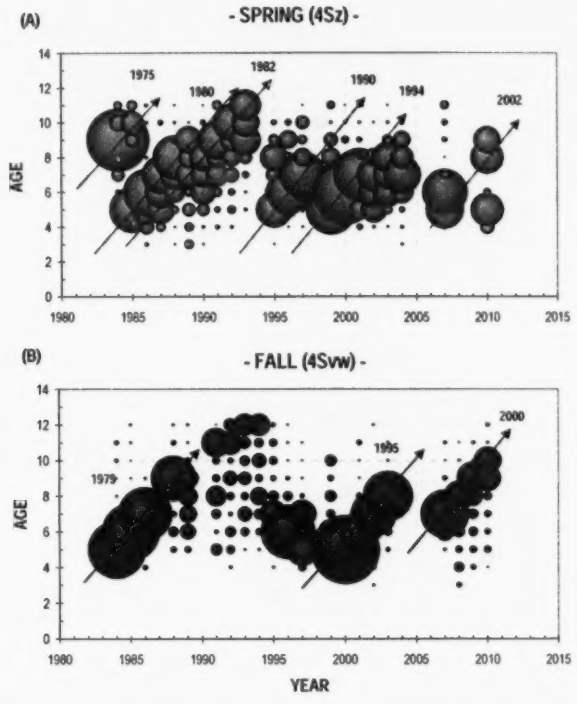

Figure 8. Annual age frequencies (%) of spring (4Sz) (A) and fall (4Sv, 4Sw) (B) herring from commercial fishery samples on the North Shore of Quebec (NAFO Division 4S), between 1984 and 2010. The dominant year-classes are indicated.

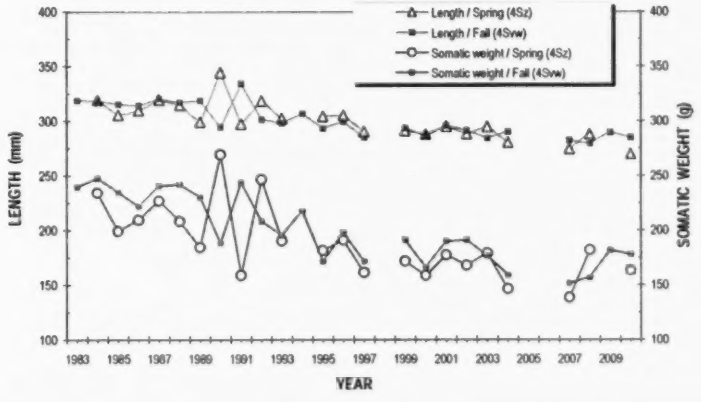

Figure 9. Mean length (mm) and somatic weight (g) at age five of spring (4Sz) and fall (4Sv, 4Sw) herring from commercial fishery samples on the North Shore of Quebec (NAFO Division 4S), between 1983 and 2010.

Gonadosomatic index

Both Quebec North Shore herring spawning stocks are distinguished by the degree of maturity of their gonads and by their gonadosomatic indices. For spring spawners (Division 4S EAST and WEST), the gonadosomatic index is between 10% and 20% from the end of April (day 110) to the end of June (day 175) (Figure 10). After spawning, which takes place quickly, the index remains at under 5-6%. For fall spawners, the gonadosomatic index is usually under 5-6% until early June (day 150) before increasing rapidly and reaching values of 15% and higher by mid-July (day 200).

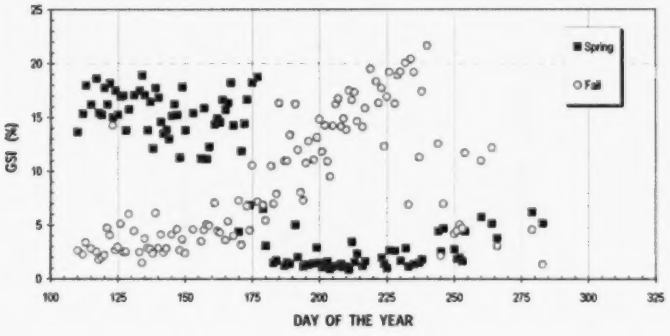

Figure 10. Mean gonadosomatic index (GSI) calculated by day for the period between 1983 and 2010. Calculations are done for each spawning group and for all of Division 4S.

Maturity

The proportion of maturity at length has changed little over the years. For spring spawners, the length at which this proportion reaches 0.5 (50%) (L_{50}) was over 250 mm between 1983 and 1989 and at 250 mm or less thereafter (Figure 11A).

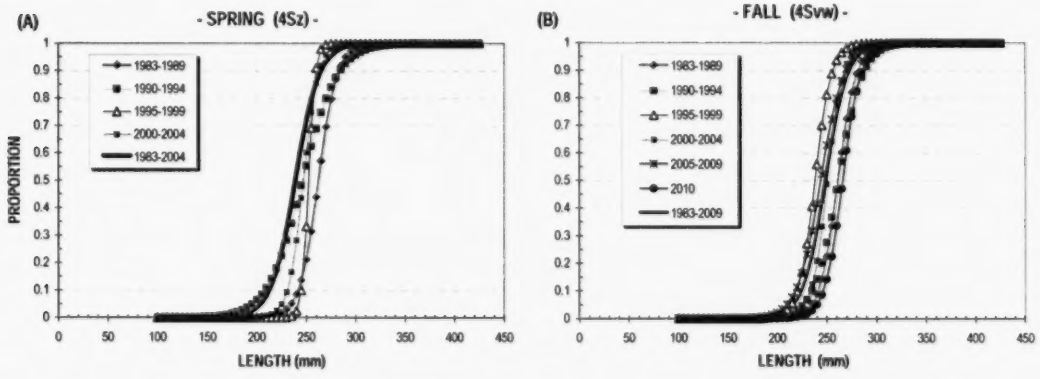

Figure 11. Mean proportion of maturity at length of spring (4Sz) (A) and fall (4Sv, 4Sw) (B) herring on the North Shore of Quebec (NAFO Division 4S), between 1983 and 2010.

For fall spawners, L_{50} was over 250 mm between 1983 and 1994 and in 2010 (Figure 11B). For these two spawning groups, most of the herring of 300+ mm were mature.

Resource Status

Multidisciplinary bottom trawl survey

Abundance (kg/set) and dispersion index

Herring is a regular catch of multidisciplinary bottom trawl surveys carried out annually in the northern Gulf of St. Lawrence. Although catches per set are relatively small, herring is caught in almost the entire sampled area covered by these surveys (Figure 12). Over the years, the highest catch rates (kg/set) were observed in the St. Lawrence Estuary, along the Laurentian Channel, between Anticosti Island and the west coast of Newfoundland, as well as in the Strait of Belle Isle.

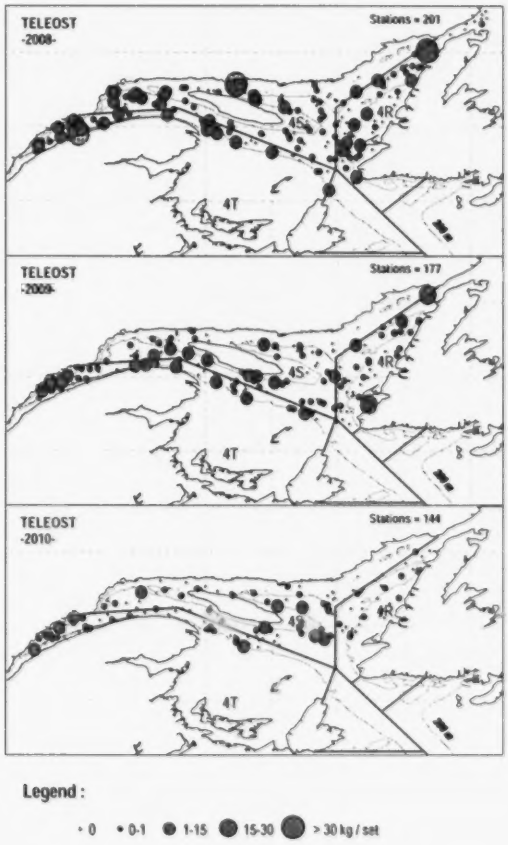

Figure 12. Herring abundance distribution (kg/set) for the last three multidisciplinary bottom trawl surveys by the CCGS Teleost in the Estuary and northern Gulf of St. Lawrence.

Multidisciplinary bottom trawl surveys are not appropriate for catching and measuring the abundance of a pelagic fish such as herring. For this reason, only the presence/absence data

are used to calculate, using a geostatistical approach (indicator kriging), the surface associated with different probabilities of finding herring (Figure 13).

Compared to 2008 and 2009, the probabilities of finding herring in the 2010 survey were lower for regions south and west of Anticosti Island and south-west of Newfoundland (Figure 13). There is also some uncertainty about the probabilities calculated for the latter region due to the low number of stations that were sampled.

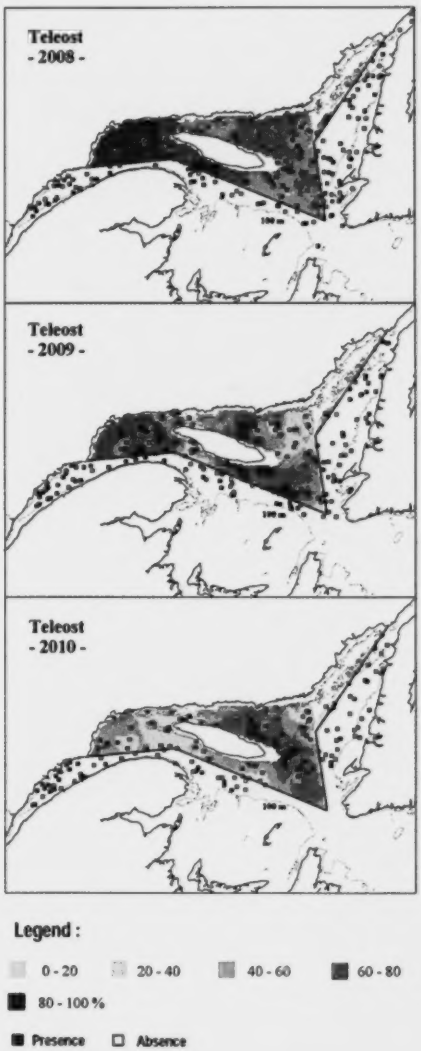

Figure 13. Herring occurrence probability surface contours (%) in NAFO Division 4S for the last three multidisciplinary bottom trawl surveys conducted by the CCGS Teleost.

The probabilities of finding herring were used to calculate a dispersion index. This index varied little between 1994 and 1996 and increased rapidly between 1997 and 2001 (Figure 14). The

dispersion index decreased thereafter and then increased again until 2008. It has decreased since and the 2010 value was among the lowest in the series.

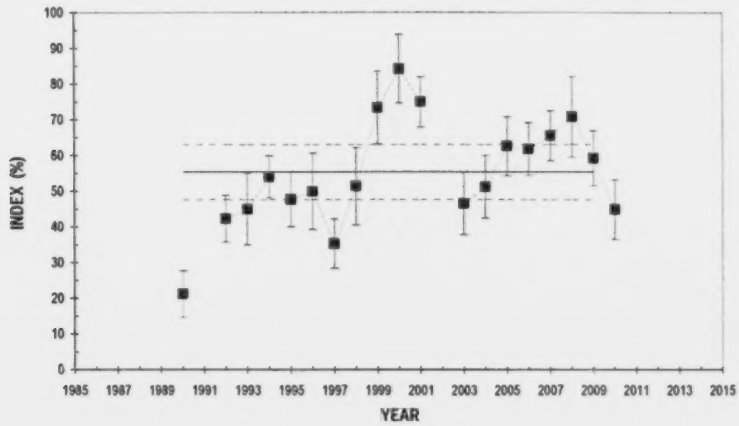

Figure 14. Mean probabilities of finding herring in NAFO Division 4S when multidisciplinary bottom trawl surveys were conducted. The horizontal lines indicate the 1990-2009 average ± 0.5 x standard deviation.

Occupation index, geographic range and concentration index

Three other indices were calculated from the multidisciplinary bottom trawl survey catches, namely: area of occupancy (DWAO), geographic range (D95) where 95% of a stock is found, and concentration (GINI). The area of occupancy has the same annual variation as the dispersion index (Figures 14 and 15A). Between 1990 and 2001, a general upward trend was observed in the geographic range of herring (Figure 15B). For the same period, an opposite trend was measured in the concentration of herring (Figure 15C). These two indices have changed little since 2002.

Acoustic survey

The acoustic survey in unit area 4Sw was conducted on October 21 and 22, 2010. This survey preceded by a few days the survey conducted on the west coast of Newfoundland (NAFO Division 4R). The mean length of transects was 5.6 nautical miles (NM) and all important signals were measured near the coast or in the first three NM. The total biomass index of spring spawners was estimated at 3,500 t compared to 80,855 t for fall spawners.

The acoustic survey results are only associated to unit area 4Sw and not to the entire Division 4S. Moreover, the low abundance of spring spawners calculated by this survey could be explained by the fact that, at the time of the survey, they were outside the area.

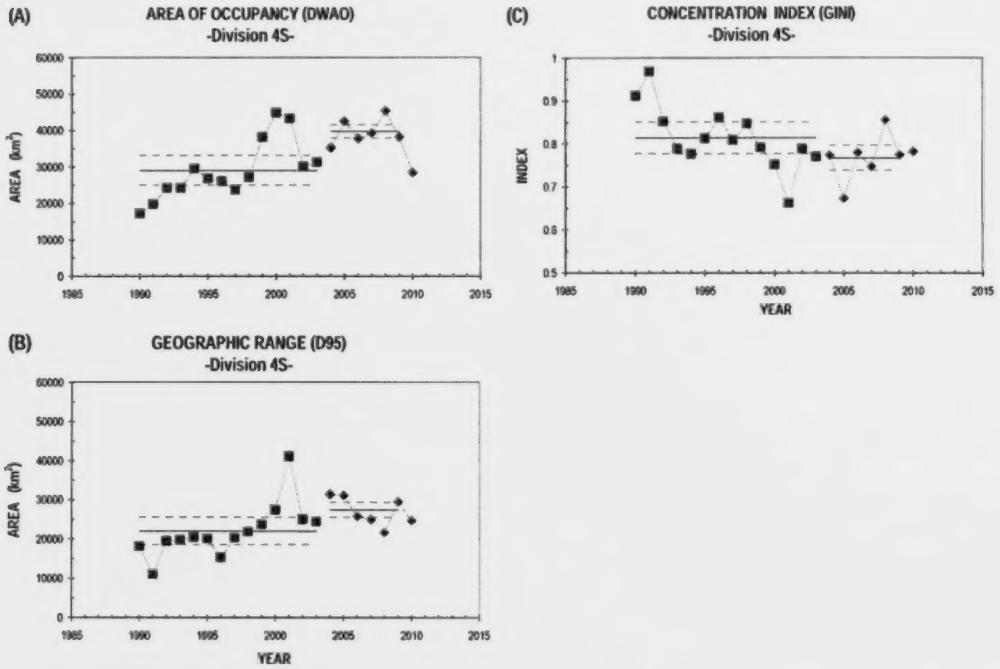

Figure 15. Indices measuring different distribution aspects of herring catches from multidisciplinary bottom trawl surveys conducted in NAFO Division 4S, between 1990 and 2010. The horizontal lines represent the average of the 1990-2003 and 2004-2009 periods ± 0.5 x standard deviation (these indices were split in two series to take account of the vessel change between 2003 and 2004) .

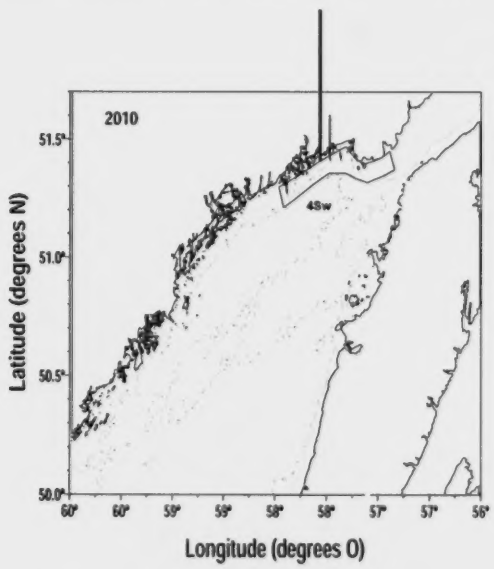

Figure 16. Density distribution (kg/m²) of herring calculated from the 2010 acoustic survey (the stratum limits are indicated; scale density is expressed by the height of the bars).

Analytical assessment

A SPA (Sequential Population Analysis) type of analytical assessment could be made from the results from at least 4 acoustic surveys. The results of this analysis would only be associated with unit area 4Sw. Also, with the current low level of annual catches, the current analytical models may not function properly.

Sources of Uncertainty

The main source of uncertainty is the absence of information regarding the actual size of the two herring spawning stocks of the Quebec North Shore. There is also a lack of information on the number, the location and the size of spawning grounds. Furthermore, there is very little information concerning annual migration patterns, species distribution, as well as its' role in the Northern Gulf of St. Lawrence ecosystem.

CONCLUSION AND ADVICE

Because of the current catch levels compared to other eastern Canadian regions, herring catches could certainly be higher on the Quebec North Shore. However, the current available and reviewed information in this report is not sufficient to accurately determine by how much the catches could be increased. Consequently, any increase in fishing effort on the two herring spawning stocks of the Quebec North Shore be made gradually and be accompanied by strict monitoring of the catches (commercial and bait) and biological characteristics. For the moment, herring catches on the Quebec North Shore are well below the TAC.

SOURCES OF INFORMATION

This Science Advisory Report is from the Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, regional advisory meeting of February 18, 2011 on Assessment of the Quebec North Shore (Division 4S) herring stocks. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

Grégoire, F., and J.-L. Beaulieu. 2011. Atlantic herring (*Clupea harengus harengus* L.) on the Quebec North Shore (NAFO Division 4S) in 2010. DFO Can. Sci. Advis. Sec. Res. Doc. 2011/019.

FOR MORE INFORMATION

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